HEXION™
Responsible Chemistry

Branched Vinyl Ester Copolymers for Intumescent Emulsion Paints

Coatings Trends & Technologies Summit
September 5, 2024

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Content

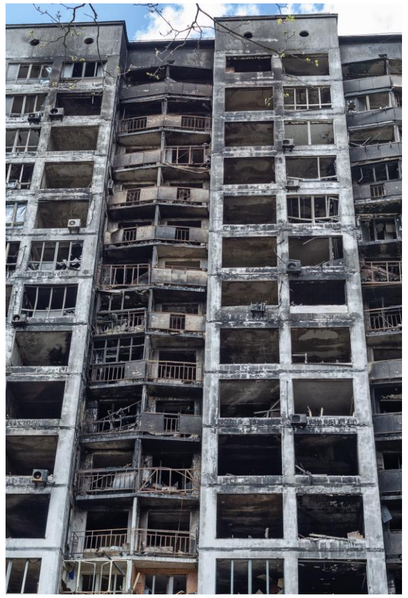
1. Intumescent Coatings
2. Highly Aliphatic Vinyl Ester
3. Performance
4. Conclusions

Section 1

Intumescent Coatings

Building Fires

The need for better fire protection



UK 2017, 73 dead

Spain 2024, 10 dead

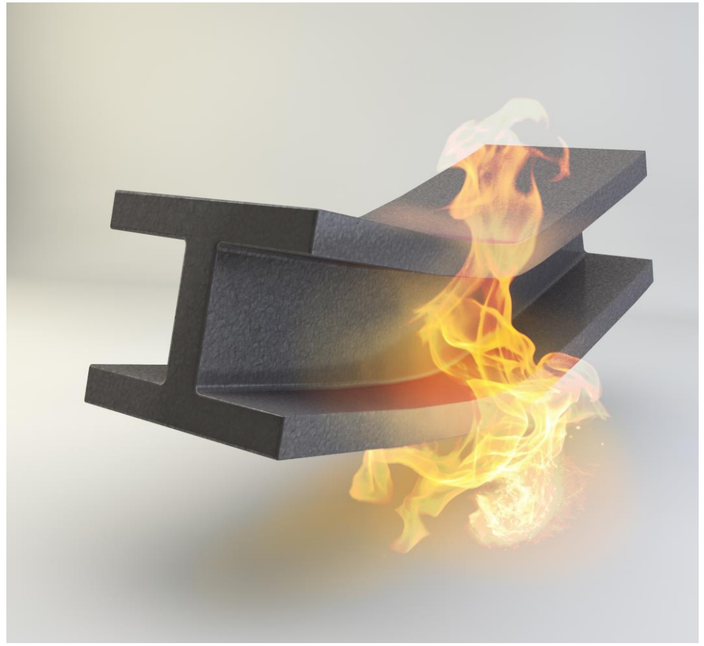
China 2024, 15 dead

Residential fires cause an estimated 3000 deaths in the USA and 5000 in EU each year

Structural Protection with Intumescent Coatings

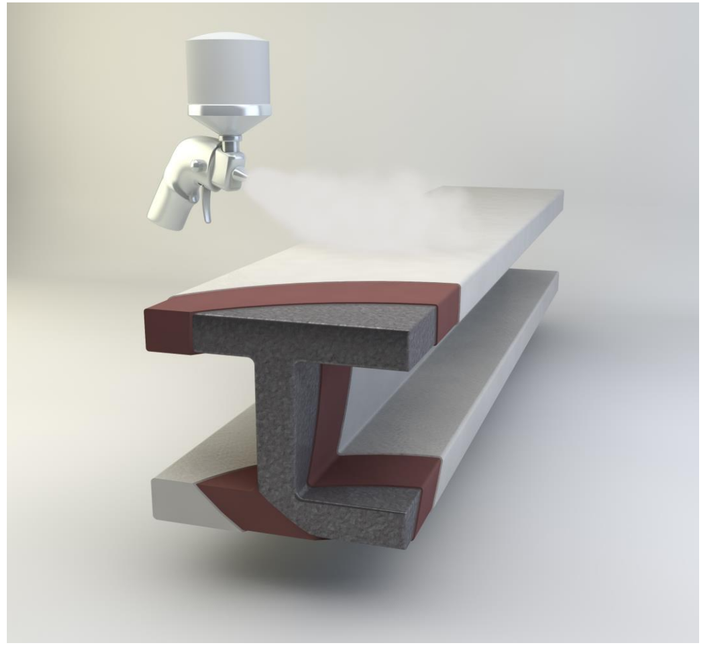
Basics

Unprotected steel



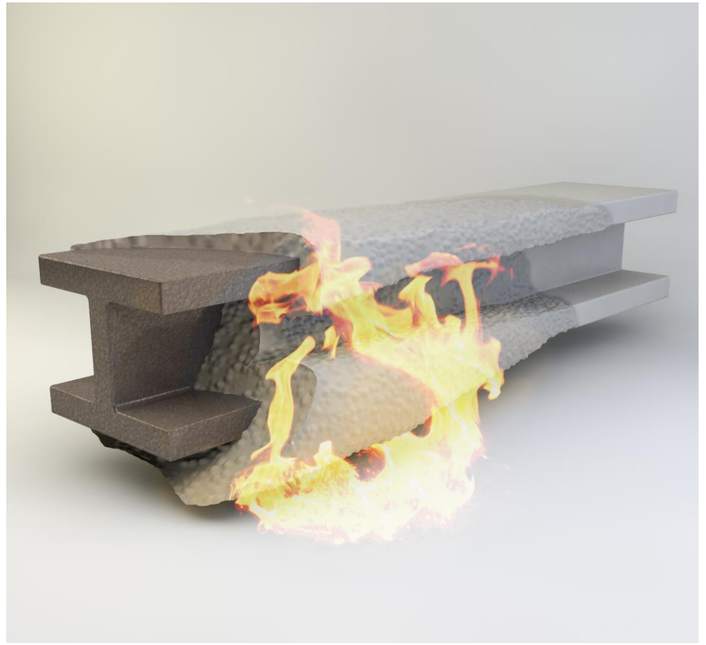
500°C: Steel strength loss
Fire resistance < 30 min

Steel protected with intumescent coating



Application: airless-spray, brush, roller

Steel protected with intumescent coating in a fire scenario



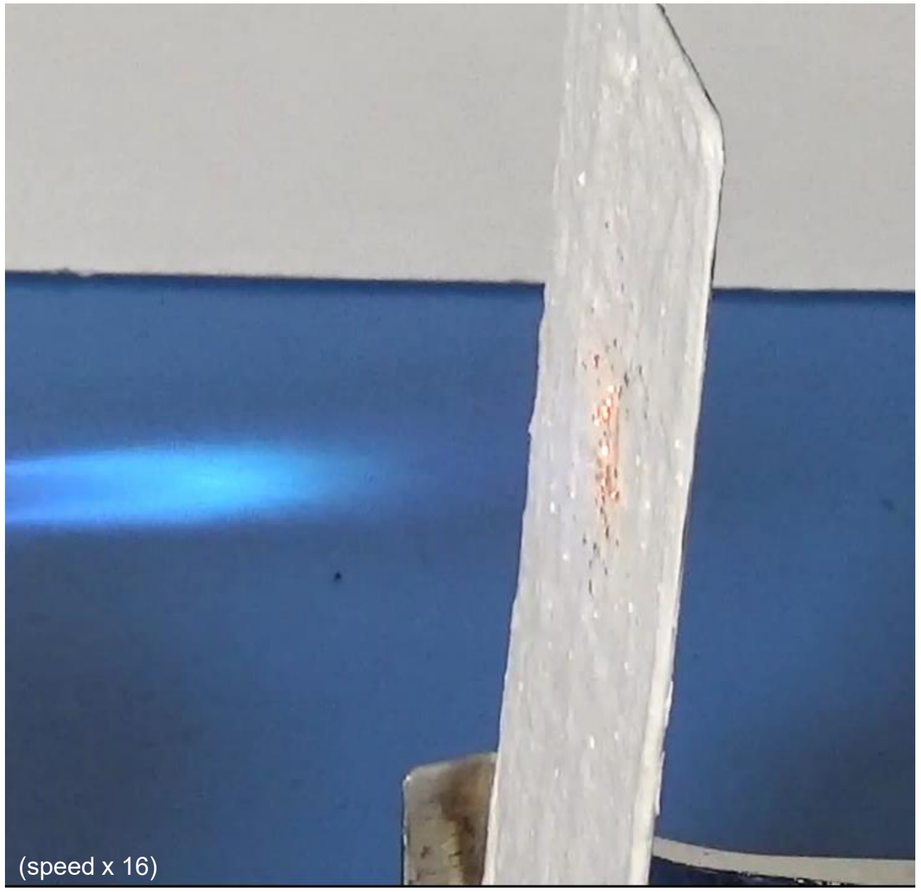
Steel with intumescent: tests compliance

Source: Clariant©

How Intumescent Coatings Work

Expanding to protect and insulate

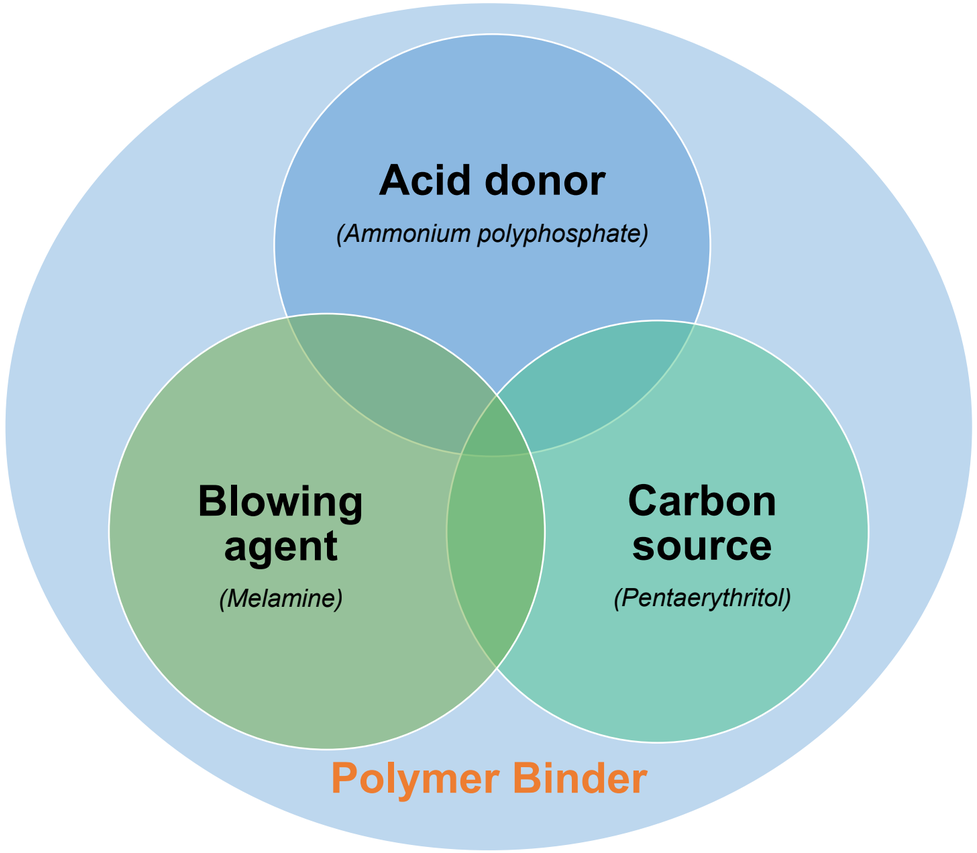
- Extends structural properties of the substrates
- Swells when submitted to heat (≈ 300°C)
- Creates thermal insulation layer = char



Intumescent paint based on **Vinyl Acetate/Vinyl Neodecanoate** binder
(30wt% Vinyl Neodecanoate monomer)

Key Ingredients of Intumescent Coatings

Key components:



- First, the acid donor breaks down to yield an acid.

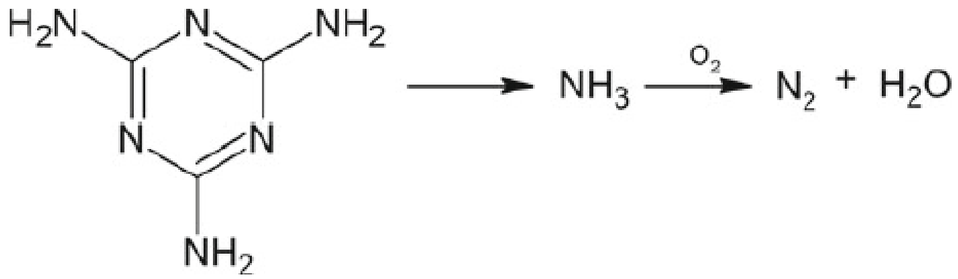
$$(NH_4PO_3)_n \xrightarrow[-\ n\ NH_3]{>250^oC} (HPO_3)_n$$

Polyphosphoric acids

- Then, the acid takes part in the dehydration of the carbon source to yield the carbon char.

$$(HPO_3)_n + C_x(H_2O)_m \longrightarrow [\,-C-\,]_x + (HPO_3)_n{}^* m\ H_2O$$

- Finally, the blowing agent decomposes to yield a gaseous product that expands the char.



Fire Types and Intumescent Coatings

CELLULOSIC FIRES

Combustible: timber, paper, furniture, textile
500°C reached in 5 min.

➡ Mainly **Vinylics**, (Styrene)/Acrylics
(50%WB, 25% SB, 25% HS EP)

HYDROCARBON / JET FIRES

Combustible: oil, gas
1000°C reached in 5 min.
Radiation value: >3 times cellulosic fires.

➡ Epoxies

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Waterborne Cellulosic Intumescent Coatings

Current trends & unmet needs

- Growing market worldwide

- Looking for:
  - Longer protection (>2h)
  - Application easiness/ thin layers
  - Outdoor durability

- Styrene/Acrylic, All Acrylic and Vinylic binders can be used for this application

- Vinyl acetate-based binders provide best intumescent performance for cellulosic fire

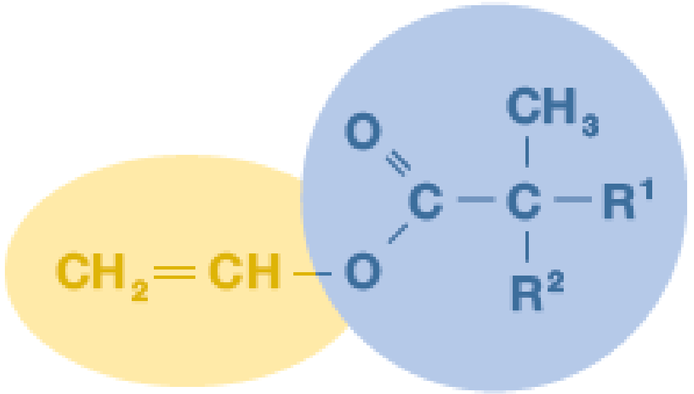
- Vinyl neodecanoate is the ideal co-monomer to upgrade performance

Section 2

Highly Aliphatic Vinyl Ester

Highly Aliphatic Vinyl Ester

Vinyl neodecanoate



Vinyl neodecanoate 10 monomer (VN10)

$R^1 + R^2$ = 7 carbon atoms

- Vinyl Ester

Easily copolymerisable with vinyl acetate

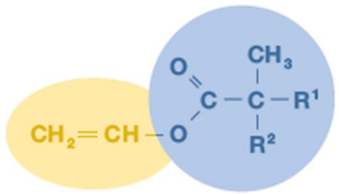
- Aliphatic bulky structure

- Bulky alkyl chain
- Steric hindrance

Vinyl neodecanoate has inherent properties that enable high-performance waterborne applications

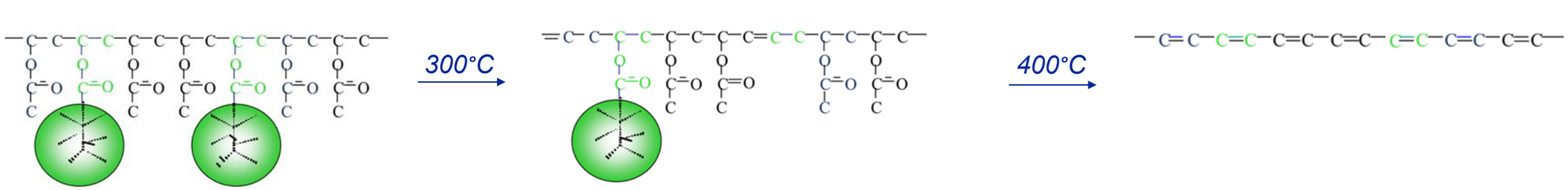
Benefits of Vinyl Neodecanoate in Intumescent Coatings

Waterborne Vinyl Acetate /Vinyl Neodecanoate binders



- **Advantages of vinyl neodecanoate**
  - **Hydrophobicity**
  - High **branching** level
  - **Stability**
  - Specific thermal **degradation mechanism**

Compensate for low durability of vinyl acetate-based binders
Protect additives sensitivity to humidity, acids… (APP, PER)
Improve **char formation**
Outperform acrylic systems, especially for thick layers



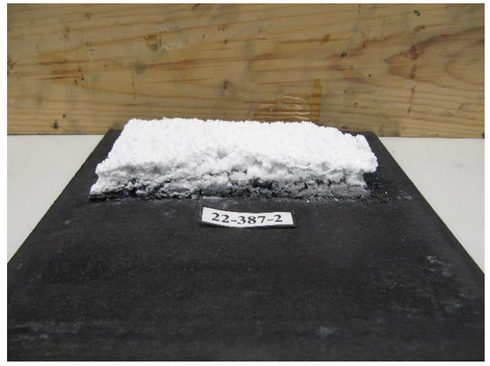
Vinyl neodecanoate based polymers expected to provide better intumescent performance

Section 3

Performance

High Carbon Content and Excellent Char Formation

Low VN10 content → High VN10 content

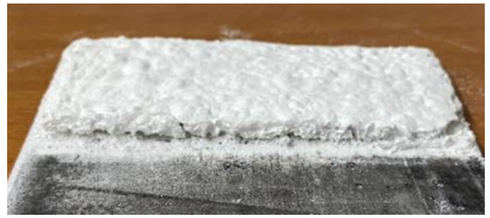


Vinyl neodecanoate content in the binder	**0 wt%**	**15 wt%**	**30 wt%**	**50 wt%**
Time to reach 500°C	73 min	77 min	86 min	94 min
Expansion factor	30	40	48	52

Increasing vinyl neodecanoate monomer content in the binder enhance both the expansion factor and fire resistance

Better Performance versus Other Chemistries



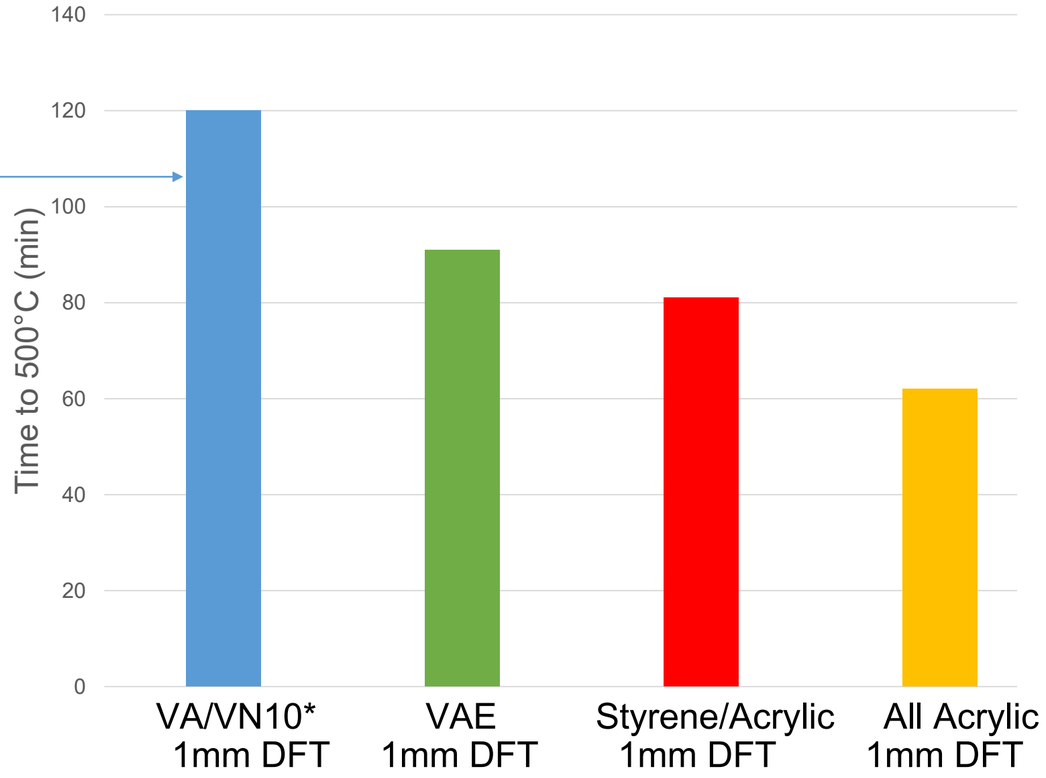



Binder type	VA/VN10*	VAE	Styrene/Acrylic	All Acrylic
Time to reach 500°C	> 120 min	91 min	81 min	62 min
Expansion factor	22	2	4	3

**50/50*

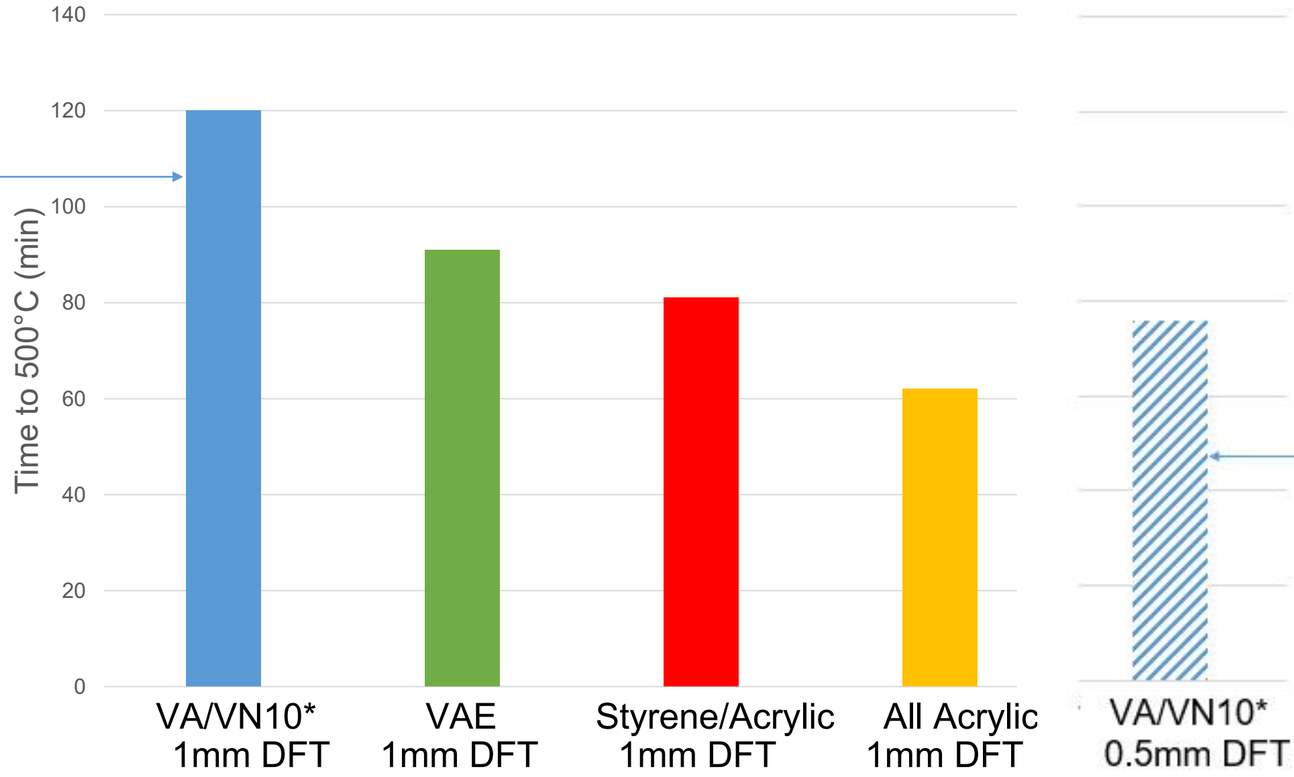
Vinyl neodecanoate monomer enables better intumescent properties

Premium Fire Protection at Minimal Layer Thickness



*50/50
DFT = Dry Film Thickness

Premium Fire Protection at Minimal Layer Thickness



*50/50
DFT = Dry Film Thickness

Coating thickness can be reduced by 50% using vinyl neodecanoate-based binder while maintaining performance

Performance after Ageing

Type	Exposure conditions
X	For all conditions (internal, semi-exposed & exposed)
Y	**For internal & semi-exposed conditions** (T<0°C, no rain, limited UV)
Z1	For internal conditions (T>0°C) with high humidity
Z2	For internal conditions (T>0°C) with humidity other than Z1

EU EAD 350402-00-1106:

- Fire testing after accelerated ageing
- Type Y cut-off limit: at least 85% of fire performance of unaged coating

Binder type	Vinyl Acetate/Vinyl Neodecanoate	Vinyl Acetate/Ethylene	Styrene/Acrylic	All Acrylic
Time to reach 500°C (% of unaged panel)	109 min (91%)	43 min (47%)	83 min (100%)	51 min (82%)

**50/50*

Vinyl neodecanoate allows to maintain properties under semi-exposed conditions

Performance Beyond Fire Protection

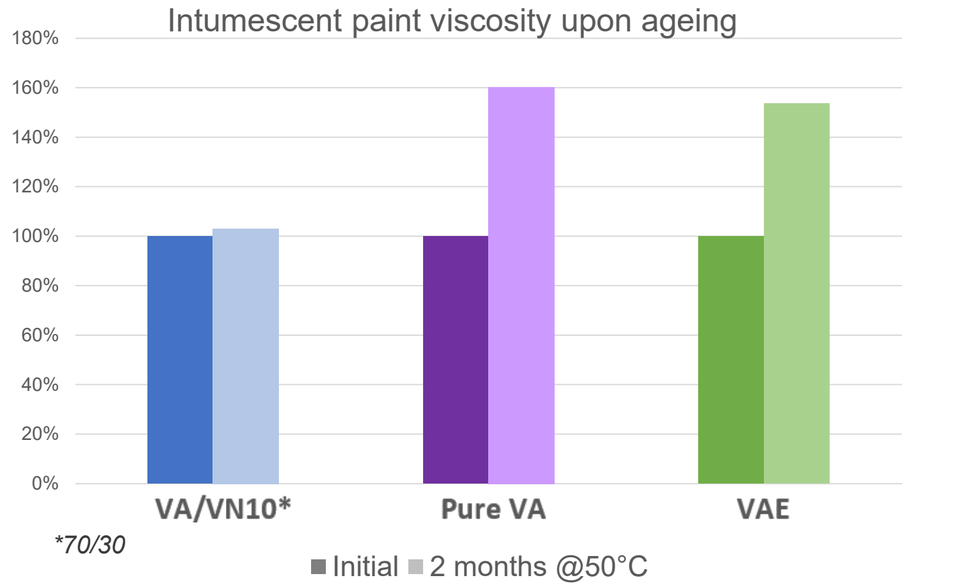
Polymer water repellency

Vinyl neodecanoate content in the binder	0 wt%	15 wt%	30 wt%	50 wt%
Water contact angle (°)	35	57	67	71

Increasing the amount of vinyl neodecanoate in the polymer binder leads to higher water repellency

Better In-can Paint Stability

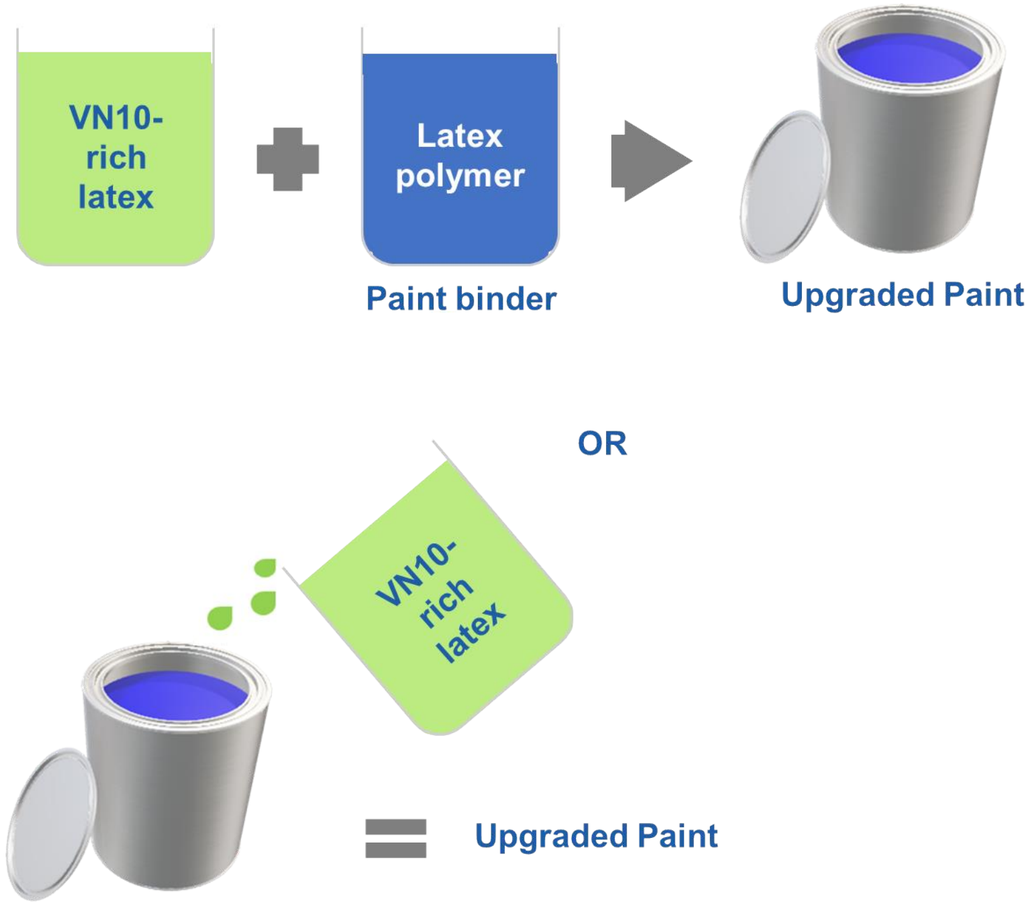
- Intumescent paints stored at 50°C for 2 months
- Viscosity monitoring



Vinyl neodecanoate enables Vinyl acetate-based paints to be viscosity stable upon storage

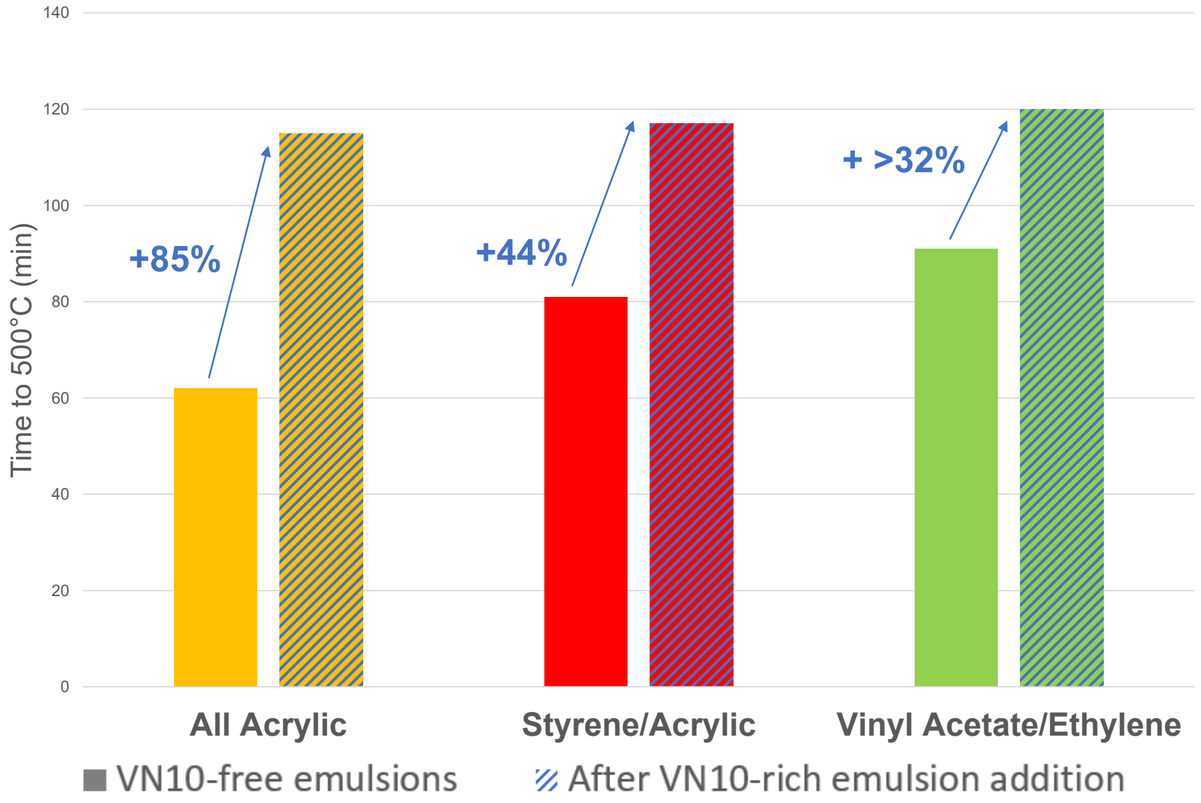
Vinyl Neodecanoate-rich Emulsion as Blending Resin

VeoPol Technology



- Vinyl neodecanoate-rich latex can be used as blending resin or as an additive to fully formulated paint
- Can be used in combination with all latex binder types including styrene/acrylic
- 1 single vinyl neodecanoate-rich latex can be used to upgrade different paint formulations
- Easy way to incorporate vinyl neodecanoate in a wide variety of applications

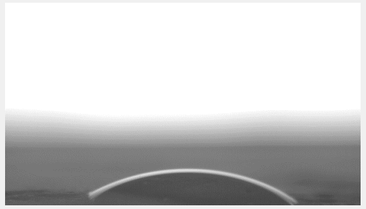
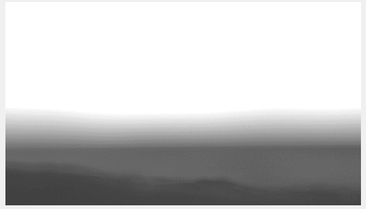
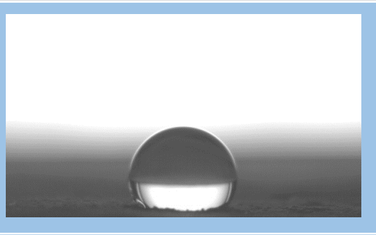
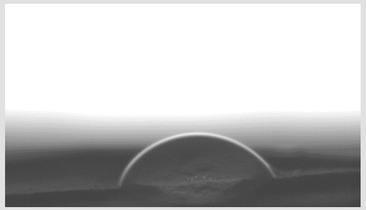
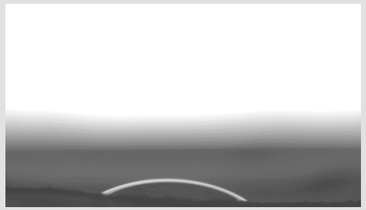
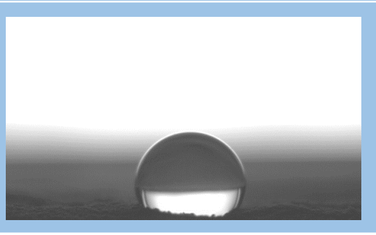
Blending Resin Fire Performance



35 wt% of binder replaced by the vinyl neodecanoate-rich binder.
Vinyl neodecanoate content in the final binder blend: 30wt%.

Better intumescent properties are achieved with the addition of vinyl neodecanoate-rich emulsion

Coatings Water Repellency after Ageing

	Before ageing	After ageing (Y conditions)	
	Base emulsion	Base emulsion	Base emulsion + VeoPol
Polyvinyl Acetate			
Styrene/Acrylic			

VeoPol improves water repellency of PVA and Sty/Acr and maintains it after ageing

Blending Approach for Emulsion Upgrade

Addition of vinyl neodecanoate-rich emulsion – Intumescent coating properties

	BENCHMARK commercially available emulsion for intumescent coating application	**Modified BENCHMARK** upgraded with addition of **Vinyl neodecanoate-rich emulsion**
Before ageing		
After 160h QUV ageing (EN 927-6)		

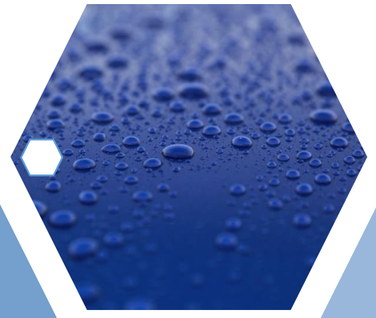
Zinc phosphate primer (80-120µm – 1 week RT drying)
Intumescent paint coat (1mm wet – >2 weeks RT drying)

Vinyl neodecanoate-rich emulsion addition enables better weathering resistance when blended with a standard emulsion

Section 4

Conclusions

Highly branched & carbon-rich structure

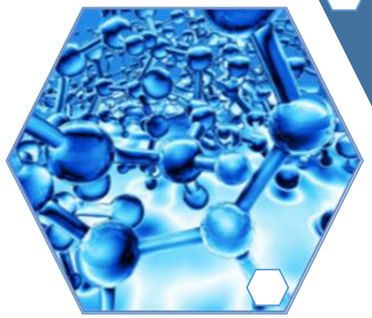


Better char formation

Versatility: co-monomer or blending resin

Increased hydrophobic character

Hydrophobicity, hydrolitic and UV stability



Synergy with intumescent additives

Improved intumescent performance

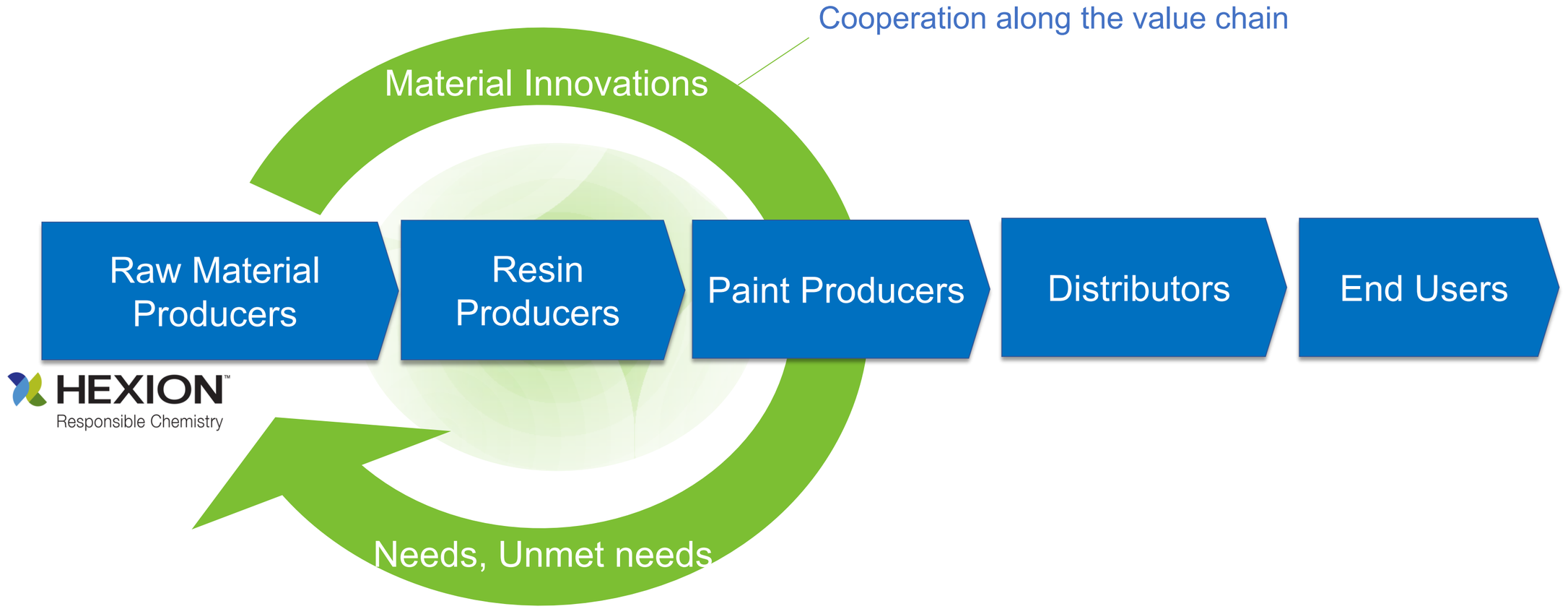
Suitable for semi-exposed conditions

Premium fire protection at minimal layer thickness

Vinyl Neodecanoate Monomer for High-Performance Intumescent Coatings

Hexion Versatics

Customer-Driven Innovation Approach



Come to discuss with us

Thank you for your attention

Learn more at Tabletop #13

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